Magnetic Resonance Imaging of Pressure Sores in Spinal Cord Injured Patients: Accuracy in Predicting Osteomyelitis

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Objective: Identify key magnetic resonance imaging (MRI) features that have a significant correlation with osteomyelitis of pressure ulcers in spinal injury patients. **Design**: Retrospective review study. **Participants**: Adult patients admitted to the National Spinal Injuries Centre with spinal cord injury (SCI) and signs of pressure ulceration investigated with MRI. **Methods**: Analysis of MRI examinations and clinical records collected over a 4-year period. Images were independently assessed by 2 experienced radiologists for osteomyelitis based on assigned predictive indicators including cortical bone erosion, soft tissue edema, deep collections, heterotopic new bone, hip effusion, and abnormal signal change of the marrow. **Results:** Thirty-seven patients underwent 41 MRI scans. The prevalence of osteomyelitis was highly correlated with cortical bone erosion (r = 0.84) and abnormal bone marrow changes on T1-weighted images (r = 0.82). **Key words:** *osteomyelitis, pressure ulcers, spinal cord injury*

Patients with spinal cord injuries (SCI) are at a high risk of developing pressure sores due to decreased mobility and lack of sensation, with a reported prevalence between 23% and 33%,[1,2] the lifetime risk estimated between 25% and 85%,[3] and an associated mortality of 7% to 8%.[4-6] Complex pressure sores are associated with adjacent complications including low grade soft-tissue infection, fistula or abscess formation, sinuses, septic arthritis, heterotopic ossification, and osteomyelitis. These complications, especially osteomyelitis, can be difficult to assess by physical examination alone; this results in delayed diagnosis and onset of treatment that leads to prolonged hospitalization and in complicated cases requires surgical intervention and deforming bone debridement.

The gold standard for the definite diagnosis of osteomyelitis is histology of bone biopsy and the identification of the causative microorganism by tissue culture. Histological examination requires invasive sampling, and microbiological tissue culture can sometimes become cross-contaminated with pathogens present in the skin and soft tissue of pressure ulcers and draining wounds.[7]

Current imaging modalities employed in identifying the presence of osteomyelitis in pressure ulcers includes bone scans, ultrasound, plain films, computed tomography (CT), bone biopsy, and MRI. Bone scan reliably excludes bony infection,[8-13] but it is not specific for the diagnosis of osteomyelitis that is affected by adjacent soft-tissue infection, the presence of orthopaedic devices, trauma, healing fractures, arthritis, surgery, or diabetes.[12,14-16] Ultrasound is not helpful for visualizing bone changes associated with osteomyelitis, nor can it detect associated surrounding soft-tissue infection,[17] but it can be useful in the detection of fluid collection in joint or soft tissue.

CT and plain films require the use of radiation and are limited in their ability to predominantly show bone changes. The overall sensitivity of CT and plain film to detect osteomyelitis is 61% and the specificity is up to 69%.[18]

MRI has been recognized for its exceptional soft-tissue bone marrow contrast resolution and multiplanar capability, which offers greater anatomical detail than CT or conventional plain films.[19] The sensitivity of MRI for the diagnosis of osteomyelitis has been reported between 82% and 100%, and specificity between 75% and 96%.[20] Huang et al reported in 44 patients that for the diagnosis of

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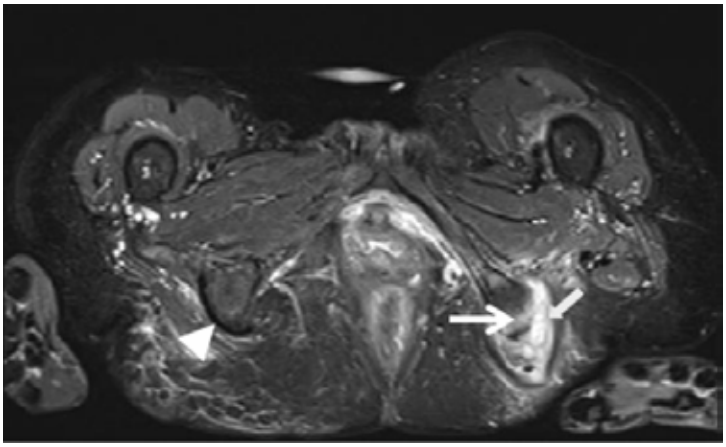

Figure 1. Axial STIR image of both ischia. Acute cortical erosion (arrow on far right) and bone marrow edema (white arrow). Normal bone cortex (arrow head).

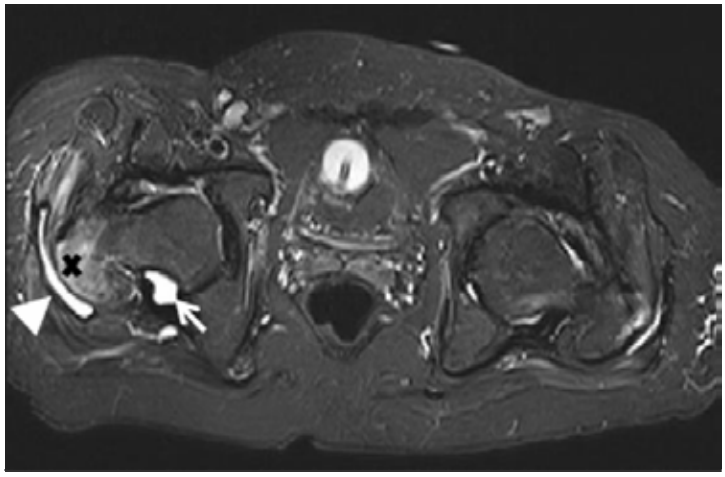

Figure 2. Hip axial STIR image. Early evidence of osteomyelitis with bone marrow edema (x) and adjacent deep collection (arrow head). There is a small hip effusion (white arrow)

osteomyelitis, MRI with gadolinium enhancement has an overall accuracy of 97% when correlated with histological findings and microbiological cultures from bone biopsies[16]; this renders it very useful in helping with decisions in management of pressure sores, especially in preempting early surgical intervention.

As MRI has become increasingly important in the diagnosis and management of pressure ulcers and osteomyelitis, reliability and agreement in the identification of key predictive indicators amongst radiologists are crucial.

In this retrospective study covering 4 years, the MRI scans and clinical records of adult spinal patients admitted for pressure ulcers to the National Spinal Injury Centre, Stoke Mandeville Hospital, were compared. The correlation of osteomyelitis with several MRI predictive indicators was assessed independently by 2 experienced radiologists. The assigned predictive indicators included cortical bone erosion, soft-tissue edema, deep collections, heterotopic new bone, hip effusion, and abnormal signal changes of the marrow on T1-weighted and STIR images.

Thirty-seven SCI patients with an indication of pressure ulcer underwent 41 MRI scans. Acute cortical erosion and deep collections were seen in approximately a third of patients (38% and 31%, respectively). Soft-tissue edema was the most prevalent feature (86%). Heterotopic new bone and hip effusion were seen in 16% and 28%, respectively. Abnormal marrow signal was more prevalent on the STIR sequences (75%) compared to the T1-weighted images (53%). There was a significant association between the prevalence of osteomyelitis and cortical bone erosion (Pearson's $r = 0.84$) with a sensitivity and specificity of 90% (**Figure 1**). There was further significant association between osteomyelitis and abnormal marrow edema, best demonstrated on T1-weighted images ($r = 0.82$), with a sensitivity of 81% (**Figure 2**) compared to 51% on the STIR images. Deep collections, heterotopic new bone formation, and hip effusion were not of significant predictive value in assessing the risk of osteomyelitis.

In conclusion, acute cortical bone erosion and abnormal marrow edema, in particular on the T1-weighted images, have a strong correlation with osteomyelitis in spinal patients with pressure ulcers. The use of MRI in evaluating SCI patients with indication of pressure ulcers and suspected pelvic osteomyelitis can diminish delays in diagnosis, accelerate treatment, and eliminate unnecessary studies and interventions.

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